PRELIMINARY STUDIES OF FLYING FOXES' DIET INTAKE AS AN INTEGRATION WORK BETWEEN KEEPERS AND NUTRITION STAFF AT TEMAIKÈN

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Abstract

During 6 months, as part of an integration experience, keepers and nutrition staff worked together to study the flying foxes' (*Pteropus vampyrus* and *Pteropus lylei*) diet intake at the Temaikèn Wild Animal Park. At the beginning of the study, animals weighed an average of 763.84 g in the case of the former, and 398.8 in the case of the latter. During a first 5-day period, diet weights, scraps and leftovers were controlled. In the second period, novel ingredients and new feeders were tried. The roost trees and the floor conditions were changed. After that, during a third 7-day period, diet weights and leftovers were controlled again. Feed intake could not be compared but animals weights improved to an average of 874.92 g and 468.86 g respectively. The diet offered at that time weighed 39.56 kg. Preferred ingredients could be determined and competition was kept to a minimum.

Introduction

The Old World Fruit Bats, family Pteropodidae, that include *Pteropus lylei* (Lyle's Flying Fox) and the largest species of *Pteropus*: *Pteropus vampyrus* (Large Flying Fox) are found in the Tropical and Subtropical regions of the Old World.[9]

Lekagul and McNeely (1977) reported that *P. lylei* forms very large colonies and groups of *P. vampyrus* often exceeding 100 individuals[8]. Although Gould (1977) observed individual *P vampyrus* to defend an entire tree while feeding.[3]

P. vampyrus is considered in Appendix II of CITES. And the 2002 IUCN/SSC has deemed it not threatened (Low Risk). On the other hand, *P. lylei* is seen as a serious pest by fruit growers in Thailand[9].

These bats are active mostly in the evening and at night but have been observed flying in the daytime. At dusk they fly to fruit trees to feed. They often make long flights between their roosting and feeding areas. Most species of this family locate food by smell. The principal food of *Pteropus* is fruit juice, which the bats obtain by squeezing pieces of the fruit pulp in their mouth. They crush ripe fruit pulp in their mouth, swallow the juice, and spit out most of the pulp and seeds, often pressed into almost uniformly shaped pieces. Some of the softer pulp is swallowed.[9]

This informal study was conducted as an integration experiment between keepers and nutrition staff to solve the following common problem. As the Temaikèn flying foxes had low weights, their diet intake had to be evaluated and improved. Also, leftovers had to be

reduced, in order to achieve a more efficient use of resources. Additionally, during observations, competition and perching places were analyzed in order to improve the distribution of the feeders and the design of the roosting trees of the exhibition area.

Materials and Methods

Integration between the keepers and nutrition staff started at the first meeting, in which the targets and work routine were established by supervisors. The study and the integration experiment were carried out during 6 months. The first part of the experiment was at the end of the winter, when one Nutrition Staff member worked together with two Keepers. The second part was at the end of the summer and on this occasion two Nutrition Staff members and three Keepers were involved.

Usually, in the nutrition area, the Nutrition Staff prepare the diet, weighing each ingredient and delivering it to the keepers' area, where keepers peel the fruit, put it into the feeders and hang it on the trees in the exhibition area. During this experiment, the nutrition staff and the keepers worked together during the morning in the indoor area of the flying foxes, preparing the kebabs and controlling the weights of the peels.

The 21.6 m x 12 m x 7 m exhibition area, where the study was carried out, had a controlled temperature (77°F or 25°C) and controlled humidity (65%). At the beginning of the trial two principal trees where animals roosted and fed were changed for others that had better branches for perching, at the suggestion of the staff. These last branches were more numerous, more horizontal and thinner than the first ones. These 4-meter trees did not stop the bat flights. The floor was made of soil and some ropes linked the trees with it, to allow climbing.

At the beginning of the trial there were pebbles under the trees, then modifications were made to improve the cleaning of the area; a cement floor, that looked like soil, was built under the two new trees. These modifications altered the results of the leftover weights of the second part of the trial since water did not drain and so they were heavier.

During the first period, there were 31 *Pteropus vampyrus* and 17 *Pteropus lylei*. The diet offered at that time was 44.88 kg of whole fruits, nectar and vegetables as fresh matter (0.935 kg per animal). In the second period, the number of animals decreased to 30 and 12 respectively. During this period the diet offered was 39.56 kg (0.941 kg) as fresh matter and included a different proportion of the known ingredients and the new ones. This owed to the results of the first period observations and the novel items listed in Table 1. The diet was formulated using Zootrition and following the preliminary target nutrient levels of the Fruit Bat Husbandry Manual[2].

Table 1: Diet offered to the flying foxes (*P. vampyrus* and *P. lylei*) during the two periods of the diet intake study at Temaikèn Wild Animal Park.

	Diet 1 (kg)	Diet 2 (kg)
Apple	8	1.5
Artificial nectar (home made)	0	1.5

Banana	5	6
Boiled egg	0.770	1.5
Broccoli	1.14	
Cabbage		2
Calcium Supplement (Calcificante PG- Brouwer- Dr Rafael Bielsa 238, Buenos Aires, Argentina)	0.05	0.0625
Celery		0.5
Cooked Carrot	1.14	
Cooked Corn		0.25
Cooked Maize	6	6
Lettuce	1.14	2.5
Mono-calcium phosphate (Kynofos® 21- KK Animal Nutrition Pty (Ltd), P O Box 449, Umbogintwini, 4120, South Africa)		0.25
Orange	7	5.5
Peach		3
Pear	12	2
Pineapple	1.5	1.5
Tangerine		5.5
Total	**43.74**	**39.56**

In the first 5-day period the offered ingredients and the leftovers were controlled and weighed all together (non precision scale used: Sinibal®; max. weight: 10 kg, accuracy 0.1 kg). This task was repeated in the second 7-day period, with the new diet (precision scale used: Systel®- Croma; max weight: 30 kg, accuracy: 0.1 kg). The leftovers that were collected by the keepers were separated from the feces and weighed by nutrition and keepers staff. During these two periods two observations of 15 minutes were performed daily. When the diet was given, the first observation was made. At 5:00 pm keepers and nutrition staff recorded data of the animals' behavior again. Both observations were made alternatively by keepers and nutrition staff.

During a whole month, between these two periods, nine new ingredients were tried in the diet. Two observations were made during the day in order to assess the acceptance of these new ingredients, which were classified from 1 (very acceptable) to 4 (rejected) (Table 3).

After that, during two months, keepers and nutrition staff worked together proposing new ideas and modifications for the exhibition area and feeders to improve diet intake and reduce leftovers.

In the first part of the trial 19 flying foxes feeders were used (2.63 animals per feeder). (Photo 1) The flying foxes feeders were 39–cm stainless kebab with a 15.5 cm x 6.5 cm reservoir bellow. In the second part of the trial 17 flying foxes feeders, two dog feeders 18 cm in diameter in height, and eight nectar bottles were used (2.31 animals per feeder and 5.5 animals per bottle).

Results

At the beginning of the trial the animal weights registered an average of 398.88 g for the Lyle's flying foxes and 763.84 g for the large flying foxes. At the end of the study the same animals weighed 468.86 g (17% more) and 874.92 g (14.5% more) on average, respectively.

The averages of the weights recorded during the two periods are shown in Table 2.

Table 2: Leftovers and feed intake of the Temaikèn's flying foxes diet during the two periods of the diet intake study.

	Diet 1	Diet 2
Total Diet (kg)	43.74	39.56
Leftovers in the feeders (kg)	3.75	9.45
Leftovers in the floor (kg) **	7.3	6.71
Peels and Rests (kg) *	2.78	8.405
Diet Intake (kg)	29.91	14.995
Diet Intake as Body Weight (%)	99	47

An evaluation of the new ingredients tested is shown in Table 3.

Table 3: New ingredients tested during the Temaikèn's flying foxes diet intake study.

Ingredients tested	Evaluation ***
Tangerine	1
Chard	4
Celery	2
Cauliflower	4
Cabbage	1
Sugar beet	4
Peach	1
Medlar	1
Red cabbage	3

*** 1 = Very well consumed; 2 = Well consumed; 3 = Try but not consumed; 4 = Rejected

The order of preference of their diet items was as follows: first: romaine lettuce, cooked maize, egg and nectar; then banana and pineapple; second: pear and cooked carrot, and finally apple and broccoli. "Some other studies showed cantaloupe, romaine lettuce and flowers as preferred items"[6]. Celery resulted well consumed in the test period, but once it was included in the diet, it was rejected. That could be because "most Old World fruit bats respond to novelty"[5].

Leftovers were fewer during cloudy days and animals mainly fed at night.

Discussion

Flying foxes

Two special trees of the exhibition area were chosen to hang the feeders. Mostly during the day, animals roosted on other perches around the area. The process of developing a roosting territory on exhibit and flying to a feeding ground is a basic behavior of Old World fruit Bats[7].

During the first part of the trial oranges, pineapples and bananas were offered with peels. As the presentation of these ingredients changed, the weights of the scraps that included the peels and the rests, that were the other parts of the fruit and vegetables not offered in the second part of the trial, were increased three times (> 202 %). (*)

As described above, the conditions of the floor under the trees were changed during the trial on the recommendation of the staff, in order to facilitate the cleaning of the area. It was more difficult to collect the leftovers from the previous floor, because of the waddles, so the fact that these leftover values could be underestimated should be taken into account. On the other hand, the floor leftovers could be overestimated during the second part of the trial since the fruit water and the condensation of the moist air could not drain because of the cement, and so they could be included in the total weights of floor leftovers.(**)

Therefore, the intakes as a percentage of body-weight could not be compared and considered, although in both periods they were easily inside the values cited by Demspey and Crissey (1995): 50 – 120% of body weight on an as fed basis[2]. In future essays the same scale and dry matter intake should be considered.

Also, it is important to note that because of the seasons the daytime varied and it could have influenced feeding behavior. On this matter another type of study should be conducted with these species.

At the beginning of the trial animals perched mainly on one tree, since one of the two trees had branches that were not adequate for them. During the second part of the trial flying foxes were using the whole exhibition space and therefore competition was reduced. Food theft is a common behavior between bats, so they may find a secure location for food consumption[6]. Bats should have a variety of roosting options to provide security and to minimize aggression, as Le Blanc stated[6]. Therefore, spreading the feeders among two trees with good branches, instead of one around the enclosure, helped prevent bats with defined territories from dominating the feeders[1].

As the more numerous *P. lylei* died during the 6-month study, it could be thought that competition should be a hypothetical cause for this. But to arrive at that conclusion, a deeper analysis about inter-species competition, considering the cause of death, should be carried out.

Nectar was added in the final diet, and it was very well accepted. Our own experience showed that the greater the number of nectar feeders, the greater the nectar intake.

Competition should be taken into account when establishing the appropriate number of feeders.

The design of the feeder was thought to be weak, because the feeders had to be repaired frequently before this study. But during the trial no feeder was broken. Other types of feeders, like the 44.5cm-long stainless kebabs without reservoir and the 25 cm-high stainless dog feeders, were tried in the middle period and had good results.

Observations showed that the animals fed at night, although prior research said that they fed at twilight. Few animals chose to feed during the two observation periods.

Staff

As Irlbeck (2003) said "If an optimum diet is formulated for an animal, but the keeper does not believe in it and does not feed the diet- what good does the diet do? If a Curator or Area Supervisor is alienated because the nutritionist did not follow the "chain of command"- then they cease to be effective. We all need to work together and we all need to communicate[(4)]." During this experience, the opportunity to solve a problem and to work together allowed the Keepers to better understand the type of work that the Nutrition Staff does and why they choose particular ingredients, while allowing the Nutrition Staff to know the animals for which they prepare the diet every day better. More time working together enhances communication and the bond between personnel. Knowing how others work facilitates empathy and improves relationships. "There is a balance where there can be mutual respect and accomplishment of goals[4]".

Conclusion

One of the goals of this integration experience, was to determinate the intake of flying foxes at Temaikèn. But studies of dry matter intake considering each type of ingredient separately would be better for this target because of the exhibition area conditions.

Nonetheless, this study taught us about the consumption and preferences of flying foxes, which allowed us to improve the use of resources. Also, a better distribution of feeders, one minimizing competition was designed.

In the future, the integration work could be repeated to solve other similar problems at the Park.

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Photo 1: Flying foxes feeders at Temaikèn Wild Animal Park